Usage of multimodal maps for blind people: why and how

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ABSTRACT
Multimodal interactive maps are a solution for providing the blind with access to geographic information. Current projects use a tactile map set down on a monotouch display with additional sound output. In our current project we investigated the usage of multitouch displays for this purpose. In this paper, we outline our requirements concerning the appropriate multitouch tactile device and we present a first prototype. We conclude with future working propositions.

ACM Classification: H.5.2 User Interfaces; H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General terms: Design

Keywords: Multitouch, multimodal, haptics, map, blind, visual impairment, accessibility

INTRODUCTION

Navigating in a familiar environment is not always obvious for a blind person. In an unknown environment, it becomes especially complicated. Therefore this issue presents a social challenge as well as an important research area. The major problem is a lack of information concerning the environment which leads to deficits in orientation and mobility. These problems often mean that the visually impaired travel less, which influences their personal and professional life and can lead to exclusion from society. Many websites offer the possibility of calculating an itinerary for free. Often, this information is presented in the form of a visual map and a corresponding roadmap. The roadmap is accessible using a screen reader (technical aid for the blind for accessing the screen content), but sequential access to information in the roadmap is limited to the important steps of an itinerary and does not help to understand the environment, which is necessary to enable a flexible and autonomous navigation (e.g. a change of itinerary in case of roadwork). Visual maps are very useful for spatial knowledge but are inaccessible.

Although human tactile capacities differ from visual capacities (e.g. tactile spatial discrimination is less precise, tactile information is mainly perceived serially and not in parallel, etc.), tactile maps are used to represent geographic information for the blind. As stated by Jacobson [4] these maps have numerous limitations, for example they are static. A solution to improve accessibility to spatial knowledge might be offered by multimodal interactive maps, by using a tactile map that is placed on a touch device. The device reacts to touch events and associates a sound output to the elements on the map targeted by the user, indicating for instance a street name. Projects like ABAplans [1] or MVI [3] use monotouch displays. However monotouch displays present important limitations concerning usage of interaction technologies and presentation of information. For example, information can only be obtained by simple touch events and not gestural interaction. Gestural interaction on multitouch displays would enable new possibilities, for example indicating the distance between two points on the map, zooming, etc. For this reason our project investigates the usage of multitouch displays for multimodal interactive maps.

MULTITOUCH DISPLAYS

We have identified the following requirements:

- *Technology*: it is crucial that the touch screen is usable with a tactile map placed on its surface.
- *Accuracy*: it must be possible to identify the exact position of a finger. As presented by Power [5], inaccuracy of finger position can lead to errors in the sound output of interactive maps. Accuracy is thus an important aspect.
- *Number of inputs*: Most blind seem to explore tactile maps with both hands and all 10 fingers. Tactile device should therefore provide real multitouch characteristics and if possible react to 10 inputs in parallel.
- *Size*: As explained by Tatham [7] tactile maps should not exceed a certain size (two handspans, 450 mm). Thus it is not necessary to use a large scale touch table. On the other hand it is difficult to present tactile maps in a very small size. Therefore we propose that touch displays should at least have A4 format. Evaluations of different maps with our user group show that they prefer maps in format A3.
- *Orientation*: usually, maps are presented in horizontal orientation. Thus a device should provide the possibility to be posed in this way.
- *Programmable interface*: the device should provide access to touch events and/or gestural events.

The function of a multitouch device for a multimodal interactive map for the blind is not graphical rendering but responding to touch events. Therefore there is no requirement concerning the visual quality of the display.

In order to find an adapted technology we have made several tests with touch interfaces relying on different technologies. Resistive displays react to touch events even if the contact is established using other objects (for example a pen) or through a paper. However, most resistive displays provide only monotouch input. Stantum [6] touch display offers multitouch possibilities and has been available as a development kit, but unfortunately this device is now only sold in small sizes for mobile phones. Another technology that we have tested is the projected capacitance as in the Apple Ipad and 3M™ Multi-touch Display M2256PW. Both systems work with a tactile map placed on the surface. However the size of the Ipad is too small for our map project. Finally we tested Immersion touch table ILight that is based on the technology of Diffused Illumination. This technology uses projectors and sensors placed below the surface of the display. When placing a paper on the surface, the finger position cannot be recognized and thus this technology is not fitting our project. A first test with a tactile display using a grid of infrared light was not successful. Other technologies that might work but that we could not test yet include "frustrated total internal reflection", optical "out-of plane" (sensor above the surface) and "surface acoustic wave".

FIRST PROTOTYPE

A high-fidelity prototype has been realized using the Stantum touch screen [6]. The touch device is connected to the computer via a USB port and a VGA port. The computer needs a sound card for Text-to-Speech (TTS) output. A tactile map is placed on the touch device.

The prototype is composed of four modules connected by the ivy middleware [2]. A driver adapted to our requirements reacts to touch events on the display and sends them to another software module which has access to the map in SVG format. It receives these messages and uses the touch position in order to determine the element of the map that has been touched. It then sends a message with the element's ID on the ivy bus. A third module, MIM (Multimodal Interactive Map) receives messages of both modules. It reacts only to "touchdown" events as the sound output should only be triggered when the user explicitly presses on the map and not when he explores the map by following the embossment with his fingers ("touch move"). MIM then sends a message with the text output to the TTS module via ivy. Finally, the TTS module converts the string into a sound output.

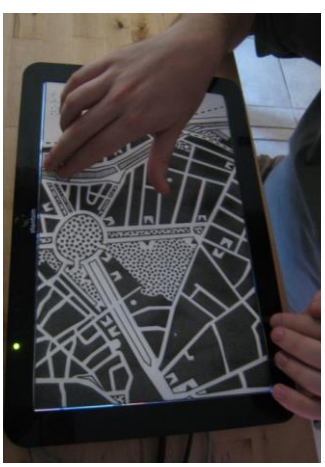

Figure 1: Prototype

The user explores the map following the embossed streets and borders with his fingers. When he wants to get information on an element, he makes a press and hears associated information (e.g. street name, name of a park or river). The application can easily be extended to add further output elements.

RESULTS AND FUTURE WORK

Preliminary results show that the users appreciate having a multimodal interactive map and that usage is pertinent for acquiring spatial knowledge. However the current implementation is too sensitive. "Touch down" events are even triggered when the user slightly moves his fingers on the display. As most blind users put all 10 fingers on the display in parallel, too many sound outputs (one for each finger) are produced. Thus, the next step will be to implement specific interactions techniques (e.g. double click) in order to distinguish between exploration movements and touch events. Another possibility would be to react to the number of fingers on the display and to provide sound output depending on this parameter (e.g. indicate an element's name for one finger and distances for two fingers, etc.). Other problems are related to technical limitations. For instance, it would be helpful to get the touch pressure as a parameter, which is unfortunately not provided by most touch displays.

The choice of touch displays is limited. It will be interesting to further examine other technologies and, specifically if they address the requirements presented in this paper. Anyway, the concept of multimodal interactive maps is promising. Due to the relatively low cost of tactile devices, it seems possible that, in near future, blind users have their own multimodal map system at home.

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